- Noise added by the channel adversely affects the signal-to-noise ratio.

In summary, amplitude modulation provides an effective means for sending a bandlimited signal from one place to another. For wireline channels, using baseband or amplitude modulation makes little difference in terms of signal-to-noise ratio. For wireless channels, amplitude modulation is the only alternative. The one AM parameter that does not affect signal-to-noise ratio is the carrier frequency f_c: We can choose any value we want so long as the transmitter and receiver use the same value. However, suppose someone else wants to use AM and chooses the same carrier frequency. The two resulting transmissions will add, and **both** receivers will produce the sum of the two signals. What we clearly need to do is talk to the other party, and agree to use separate carrier frequencies. As more and more users wish to use radio, we need a forum for agreeing on carrier frequencies and on signal bandwidth. On earth, this forum is the government. In the United States, the Federal Communications Commission (FCC) strictly controls the use of the electromagnetic spectrum for communications. Separate frequency bands are allocated for commercial AM, FM, cellular telephone (the analog version of which is AM), short wave (also AM), and satellite communications.

Exercise 6.12.2

Suppose all users agree to use the same signal bandwidth. How closely can the carrier frequencies be while avoiding communications crosstalk? What is the signal bandwidth for commercial AM? How does this bandwidth compare to the speech bandwidth?

6.13 Digital Communication

Effective, error-free transmission of a sequence of bits --- a **bit stream** $\{b(0), b(1), \dots\}$ is the goal here. We found that analog schemes, as represented by amplitude modulation, always yield a received signal containing noise as well as the message signal when the channel adds noise. Digital communication schemes are very different. Once we decide how to represent bits by analog signals that can be transmitted over wireline (like a computer network) or wireless (like digital cellular telephone) channels, we will then develop a way of tacking on communication bits to the message bits that will reduce channel-induced errors greatly. In theory, digital communication errors can be zero, even though the channel adds noise!

We represent a bit by associating one of two specific analog signals with the bit's value. Thus, if $b(n)=0$, we transmit the signal $s_0(t)$; if $b(n)=1$, send $s_1(t)$. These two signals comprise the **signal set** for digital communication and are designed with the channel and bit stream in mind. In virtually every case, these signals have a finite duration T common to both signals; this duration is known as the **bit interval**. Exactly what signals we use ultimately affects how well the bits can be received. Interestingly, baseband and modulated signal sets can yield the same performance. Other considerations determine how signal set choice afects digital communication performance.